Rodent pest problems and management in eastern Africa

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Summary. Thirty-nine of the 161 rodent species occurring in eastern Africa have been reported to damage agricultural crops. The Multimammate rat (*Praomys natalensis*) and the Nile or Unstriped grass rat (*Arvicanthis niloticus*) are both primary chronic pests and periodic outbreak pests. Wheat, sorghum, maize and barley are susceptible as well as root crops, vegetables, plantation crops and stored foods. An association with rainfall following extensive drought has been identified with most rodent outbreaks involving these two species. Vegetation growth after rainfall provides abundant shelter and food conditions favouring rodent reproduction and survival. With this background information, a major rodent outbreak was predicted at the end of the severe drought that occurred between 1982 and 1985 in the Sahel or sub-Saharan region. Normal rainfall occurred in several Sahel countries during 1985 and 1986 and by August 1986 the Sudan reported very high populations of *P. natalensis*, *A. niloticus* and other rodent pests. The association between increased rainfall and rodent reproduction is also evident during non-outbreak periods although not so extreme. Pest management of predictable rodent damage requires prophylactic measures which are available but not yet adopted or adapted for use in eastern Africa.

Thirty-nine of the 161 rodent species (Honacki, Kinman and Koeppl, 1982) occurring in eastern Africa [1] have damaged one or more agricultural crops (Table 1). The primary rodent pests within this region are the Nile or Unstriped grass rat (*Arvicanthis niloticus*

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[1] Defined here to include continental countries from the Sudan to Zimbabwe to the Indian Ocean.

LUTTE AMÉNAGÉE CONTRE LES RONGEURS EN AFRIQUE ORIENTALE

Résumé

Sur les 161 espèces de rongeurs existant en Afrique orientale, 39 sont des ennemis reconnus des cultures. Les espèces les plus courantes sont *Praomys natalensis* (rat à mamelles multiples) et *Arvicanthis niloticus*, qui sévissent de façon chronique, mais qui déclenchent aussi de fortes attaques périodiques. Ils s'attaquent au blé, au sorgho, au maïs et à l'orge aussi bien qu'aux racines, aux légumes, aux cultures de plantation et aux denrées stockées. On a remarqué que les attaques de rongeurs de ces deux espèces se produisaient presque toujours après des pluies suivant une sécheresse prolongée. En effet, les précipitations stimulent la croissance végétale, leur fournissant abris et nourriture en abondance et favorisant ainsi leur reproduction et leur survie. C'est sur la base de ces observations qu'on avait prévu une forte infestation de rongeurs après la grave sécheresse qui a duré de 1982 à 1985 au Sahel et dans la région subsaharienne. Les pluies ont été normales dans plusieurs pays sahéliens en 1985 et 1986, et en août 1986, le Soudan signalait de très fortes populations de *P. natalensis*, *A. niloticus* et autres rongeurs. Il y a aussi un rapport entre l'intensification des pluies et la reproduction des rongeurs pendant les périodes de non-infestation bien que ce lien ne soit pas aussi marqué. La prévention des dégâts causés par les rongeurs passe par des mesures prophylactiques qui existent mais qui ne sont encore ni appliquées ni adaptées pour l'utilisation en Afrique orientale.

PROBLEMAS DE LAS PLAGAS DE ROEDORES EN AFRICA ORIENTAL, Y LUCHA CONTRA ELLAS

Resumen

Se ha comprobado que 39 de las 161 especies de roedores presentes en Africa oriental ocasionan daños a los cultivos agrícolas. La rata de mamas múltiples (*Praomys natalensis*) y la rata del Nilo (*Arvicanthis niloticus*) constituyen las principales plagas de tipo crónico, así como de brotes periódicos. Son susceptibles el trigo, el sorgo, el maíz y la cebada, y también los cultivos de raíces, las hortalizas, las plantaciones y los alimentos almacenados. Se ha observado una asociación entre la lluvia tras un período de sequía prolongado y la mayoría de los brotes de roedores de esas dos especies. El crecimiento de la vegetación que sigue a la lluvia proporciona a los roedores unas condiciones de protección y alimentación que favorecen su reproducción y supervivencia. Teniendo en cuenta estos antecedentes, se predijo la aparición de un importante brote de roedores al final del grave período de sequía que se registró entre 1982 y 1985 en la región del Sahel o subsahariana. Durante 1985 y 1986 se produjeron precipitaciones normales en varios países del Sahel, y en agosto de 1986 se comunicó la presencia en el Sudán de poblaciones muy altas de *P. natalensis*, *A. niloticus* y otras plagas de roedores. La asociación entre el aumento de las precipitaciones y la reproducción de los roedores es también evidente durante los períodos en que no hay brotes, aunque no en un grado tan elevado. La lucha contra las plagas de roedores cuyos daños son previsibles requiere medidas profilácticas, ya existentes pero todavía no adoptadas o adaptadas para su utilización en Africa oriental.

(Desmarest, 1811)) and the Multimammate rat (*Praomys natalensis* (A. Smith, 1834)). *A. niloticus*, a medium-sized rat (80-100 g) with coarse hair and speckled back, is diurnal and prefers grassy savannas (Kingdon, 1974). It readily consumes planted seeds, cuts thin-stemmed cereals and damages several root crops. *P. natalensis* is a smaller rodent (50-60 g) with soft hair, a grey-brown back and grey belly. It is nocturnal, omnivorous, an indigenous commensal and well known for its large litters (averaging about 11). This rat damages cereal crops at all stages and, unlike *A. niloticus*, climbs maize stalks to reach the developing ears (Taylor, 1968). Root crops are particularly susceptible to damage by this rat. Fleas from both rodent species can transmit the plague bacillus.

Other rodents frequently damage agricultural crops. The Four-striped grass mouse (*Rhabdomys pumilio* (Sparrman, 1784)) is a small (35 g), diurnal, mostly non-burrowing omnivore, found in higher altitude grasslands. Losses in cereal crops near these grasslands can be severe (Taylor, 1968), and debarking in conifer plantations has occurred in South Africa (Hechter-Schultz, 1962).

The African mole rat (*Tachyorcyctes splendens* Ruppell, 1835) is a large (200 g^{+}) fossorial rodent which mostly feeds underground. It feeds on forage crops, root crops and vegetables in the preferred moist, upland, non-forested habitat.

Tatera spp. Lataste, 1882 (commonly *T. robusta* (Cretzschmar, 1826)) are large (120 g), gregarious, burrowing rodents with long tails, large hind feet and smaller forelegs. These gerbils are adapted to dry environments. Seeded fields are susceptible to severe losses through the caching behaviour of these rodents. Root crops are affected and cotton damage has been reported in the Sudan (Schmutterer, 1969). Gerbils are the principal wild reservoir of plague.

The Crested porcupine (*Hystrix cristata* Linnaeus, 1758) is the largest (10-30 kg) rodent in Africa. It is a hardy animal, utilizing natural crevices or existing holes for daytime resting (Kingdon, 1974). Since it prefers cultivated crops, losses can be locally severe. Maize stalks have been cut to reach the ears (cobs) and root crops are readily damaged.

The Unstriped ground squirrel (*Xerus rutilus* (Cretzschmar, 1826)) and the Striped ground squirrel (*Xerus erythropus* (E. Geoffroy, 1803)) are large, 300 and 700 g respectively, diurnal rodents that cache food in their burrows. They are significant pests in semi-arid marginal farming areas where newly planted seed is broadcast.

The Cane rat (*Thryonomys swinderianus* (Temminck, 1827)) is a large (6 kg), nocturnal, non-burrowing rodent, occupying moist areas. Crops such as sugar cane provide food near marshy areas for the Cane rat, which also consumes root crops and debarks trees. A similar species, *T. gregorianus* (Thomas, 1894), prefers drier grasslands.

The Spiny mouse (*Acomyus cahirinus* (Desmarest, 1891)) is a commensal rodent pest but is also found in field crops. It has been reported as a field pest in Egypt and the Sudan (sorghum seed) and, in Uganda, *A. wilsoni* damaged maize cobs (Watson, 1950). *Jaculus jaculus* (Linnaeus, 1758), a jerboa, and *Gerbillus* spp. Desmarest, 1804, small gerbils, may be responsible for seed losses in dry, marginal farming areas. *Otomys* spp. F. Cuvier, 1824, herbivorous, Groove-toothed rats, are forestry pests and *Lemniscomys* spp. Trouessart, 1881, the Striped grass rats, cause minor damage to a variety of crops. The common commensals, *Rattus norvegicus*, *R. rattus* and *Mus musculus*, are largely restricted to urban and village habitats.

Management techniques

A common rodent control strategy, suitable for a variety of pest species, crops and agro-climatic zones, is not yet available (Fall, 1983). Throughout the tropics a number of different methods and techniques, mostly chemical, physical, or ecological, have been used (Fall, 1980, 1982). In eastern Africa appropriate techniques need to be evaluated for cost effectiveness individually or in combination.

TABLE 1. **A summary of eastern African rodent species responsible for economic damage to one or more agricultural crops or stored foods**

Family	Genus	Species	Reference
Sciuridae	*Xerus*	*rutilus*	Nandwa, 1976a, b
		erythropus	Delany, 1975; Watson, 1950
Pedetidae	*Pedetes*	*capensis*	Butynski, 1973; Kingdon, 1974; Nowak & Paradiso, 1983
Cricetidae	*Cricetomys*	*gambianus*	Harris, 1934; Hopf *et al.*, 1976; Kingdon, 1974; Taylor, 1972; Vesey-Fitzgerald, 1966
	Otomys	*angoniensis*	Green & Taylor, 1975; Taylor & Green, 1976
		denti	Kingdon, 1974
		irroratus	Hopf *et al.*, 1976; Kingdon, 1974
		typus	Coe, 1967; Fiedler, 1985
	Tatera	*robusta*	Hopf *et al.*, 1976; Schmutterer, 1969; Senzota, 1984
	Steatomys	*pratensis*	Vesey-Fitzgerald, 1966
Rhyzomyidae	*Tachyoryctes*	*macrocephalus*	Fiedler, 1985
		splendens	Fiedler, 1985; Hopf *et al.*, 1976; Jarvis, 1973; Nowak & Paradiso, 1983
Muridae	*Acomys*	*cahirinus*	Hopf *et al.*, 1976; Kingdon, 1974
		wilsoni	Watson, 1950
	Aethomys	*chrysophilus*	Smithers, 1975, 1983
		kaiseri	Nandwa, 1976b
	Arvicanthis	*niloticus*	Hopf *et al.*, 1976; Kingdon, 1974; Schmutterer, 1969; Taylor, 1968, 1972, 1984
	Dasymys	*incomtus*	Hopf *et al.*, 1976; Taylor, 1968
	Lemniscomys	*striatus*	Giban, 1978; Green & Taylor, 1975; Hopf *et al.*, 1976; Kingdon, 1974; Watson, 1950
	Lophuromys	*flavopunctatus*	Green & Taylor, 1975; Hopf *et al.*, 1976; Kingdon, 1974
	Mus	*minutoides*	Smithers, 1983
		musculus	Hopf *et al.*, 1976
	Oenomys	*hypoxanthus*	Hopf *et al.*, 1976; Kingdon, 1974
	Pelomys	*fallax*	Giban, 1978; Harris, 1934; Kingdon, 1974
	Praomys	*albipes*	Fiedler, 1985
		natalensis	Barre, 1978; Giban, 1978; Harris, 1937; Hopf *et al.*, 1976; Schmutterer, 1969; Taylor, 1968, 1972, 1984
	Rattus	*norvegicus*	Kingdon, 1974; Smithers, 1983; Taylor, 1984
		rattus	Barre, 1978; Hopf *et al.*, 1976; Taylor, 1984
	Rhabdomys	*pumilio*	Hopf *et al.*, 1976; Kingdon, 1974; Taylor, 1968, 1972, 1984; Taylor & Green, 1976
Gliridae	*Graphiurus*	*murinus*	Hubbard, 1972/3; Smithers, 1983; Vesey-Fitzgerald, 1966
Hystricidae	*Atherurus*	*africanus*	Delany, 1972; Kingdon, 1974
	Hystrix	*africaeaustralis*	Hopf *et al.*, 1976; Jarvis & LaGrange, 1982; Smithers, 1971, 1983
		cristata	Delany, 1975; Hopf, *et al.*, 1976; Kingdon, 1974; Taylor, 1972, 1984; Watson, 1950
Thryonomyidae	*Thryonomys*	*gregorianus*	Kingdon, 1974
		swinderianus	Delany, 1975; Kingdon, 1974; Smithers, 1983; Taylor, 1972, 1984; Watson, 1950
Bathyergidae	*Cryptomys*	*hottentotus*	Sidorowicz, 1974; Smithers, 1983
		ochraceocinereus	Watson, 1950
	Heliophobius	*argenteocinereus*	Harris, 1934
	Heterocephalus	*glaber*	Hill *et al.*, 1955; Hopf *et al.*, 1976; Jackson, 1973

Chemical

Rodenticides that have been tested or used in eastern Africa are summarized in Tables 2 (*Arvicanthis niloticus*) and 3 (*Praomys natalensis*). Field use of any rodenticide should adhere to registered label instructions, national laws and all regulations to increase effectiveness and reduce hazards to non-target species.

The most commonly used and available rodenticide in eastern Africa is zinc phosphide (Fiedler, 1985). It is inexpensive and when mixed with grains at low concentrations (2 percent) has apparently been effective. At higher concentrations (6 percent) primary bait shyness has been obvious. Laboratory testing (Suliman, Shumake and Jackson, 1984) and field demonstrations (Suliman, in press) in the Sudan have shown a 1 percent zinc phosphide and 1 percent vegetable oil mixture with whole sorghum seed to be effective on *A. niloticus*. This formulation appeared to be acceptable for other rodent pests as well.

Acute rodenticides, including "1080", "red squill" and thallium sulphate are no longer recommended, even though laboratory tests with these compounds on *A. niloticus* resulted in 80-100 percent deaths (Assefa, 1979). Laboratory and field tests using warfarin on this species resulted in only moderate efficacy levels (Gill and Redfern, 1977; Taylor, 1968). Other anticoagulants and one non-anticoagulant (calciferol) performed better in laboratory tests. Tantawy Omar (1984) reported success using coumatyetralyl and brodifacoum in a rodent control campaign in Egypt.

Several rodenticides have been tested for efficacy on *P. natalensis* in the laboratory (Gill and Redfern, 1979). Unfortunately, only subjective evaluations on field efficacy exist (Choate, 1975).

Physical

Flooding of burrows has been used for control of *Tachyorcyctes splendens* in Ethiopia (Fiedler, 1985). In Kenya, Kikuyu tribesmen collect *T. splendens* with snare traps set at fresh molehills (Jarvis, 1973). Stick and mud containers and raised storage huts with rat guards have been used in the region to keep rodents out of stored food (Jackson, 1973; Taylor, 1972).

Ecological

Preventive control through the removal of undesirable vegetation by cutting, burning, or ploughing was recommended by Taylor (1968). Later, Green and Taylor (1975) concluded that ground-cover removal, either by burning, grazing, hand-cutting or machine-cutting, reduced pest rodent populations of *Arvicanthis, Rhabdomys, Lophuromys, Otomys* and, to a lesser extent, *Praomys* (= *Mastomys*). Populations decreased because of increased raptor predation and emigration resulting from reduced cover, a diminished food supply or a general response to disrupted habitat.

Adjusting planting schedules to offer a susceptible crop stage when rodent populations are low has been suggested. Agronomic conditions in Burundi appear to make this feasible at least for rice and maize (Giban, 1978).

Annual seasonal trends

More than 25 African rodent species have reproductive periods that are related to rainfall patterns. Delany and Happold (1979) summarized this relationship for seven rodent species, including the Multimammate rat. Although these data are from non-agricultural habitats, the same or a similar phenomenon probably occurs in cultivated areas.

Knowing the general population dynamics of a rodent pest and relating this knowledge to crop protection are the first steps in developing a prophylactic management technique to reduce losses. Rainfall results in increased vegetation which provides rodents with increased food and shelter (Poulet, 1980). Under these favourable conditions, reproduction and survival increase, eventually leading to higher population densities.

To demonstrate this generally accepted

TABLE 2. **Selected list of rodenticides tested or used against *Arvicanthis niloticus*, the Nile or Grass rat**

Chemical	Country	Conc. %	Bait	Amt. (kg)	Crop(s)	Months	Bait spacing and placement	Total area (ha)	Lab. (L) or field (F)	Mortality %	Reference
Zinc phosphide	Kenya	3.0	Maize meal	544	Young wheat, maturing maize	Jul-Aug	5-m field edges	40 470	F	80[a]	Taylor, 1968
Zinc phosphide	Kenya	1.0-2.0	Maize/wheat flour or grain	—	—	—	—	—	—	—	DeLima, 1976
Zinc phosphide	Ethiopia	4.0	Wheat grain & 2% oil	—	—	—	—	—	L	100	Assefa, 1979
Zinc phosphide	Sudan (USA)	0.18	Sorghum grain, 2% oil & 5% sugar	—	—	—	—	—	L	~90	Suliman *et al.*, 1984
Zinc phosphide	Sudan (USA)	0.18	Cracked sorghum	—	—	—	—	—	L	~90	Suliman *et al.*, 1984
Zinc phosphide	Egypt	3.0	Cracked maize	—	Cereals, fruit orchards	—	—	—	F	"Successful"[b]	Maher Ali & Hafez, 1976; Tantawy Omar, 1984
1080	Ethiopia	0.2	Falgan(R) ready-made	—	—	—	—	—	L	100	Assefa, 1979
Red squill	Ethiopia	0.0001	Wheat grain	—	—	—	—	—	L	80-100	Assefa, 1979
Thallium sulphate	Ethiopia	2.5	Paste on bread	—	—	—	—	—	L	80	Assefa, 1979
Warfarin	Kenya	0.05	Cereal (maize meal?)	~30	Wheat & maize	Aug	5-m field edges	60 points	F	33[a]	Taylor, 1968
Warfarin	Kenya (UK)	0.025	Oatmeal	—	—	—	—	—	L	10-100	Gill & Redfern, 1977
Chlorophacinone	Kenya (UK)	0.005	Oatmeal	—	—	—	—	—	L	100	Gill & Redfern, 1977
Coumatetralyl	Kenya (UK)	0.0375	Oatmeal	—	—	—	—	—	L	100	Gill & Redfern, 1977
Coumatetralyl	Egypt	?	Maize	18.5/ha	Various	Feb-Aug	Bait stations	~400 000	F	100	Tantawy Omar, 1984 Taylor, 1983
Difenacoum	Kenya (UK)	0.005	Oatmeal	—	—	—	—	—	L	45-100	Gill & Redfern, 1977
Calciferol	Kenya (UK)	0.1	Oatmeal	—	—	—	—	—	L	35-100	Gill & Redfern, 1977
Brodifacoum	Egypt	0.005	Pellet	1.7/ha	Various	Feb-Aug	Bait stations	~400 000	F	87	Tantawy Omar, 1984 Taylor, 1983
Brodifacoum	Egypt	0.005	Pellet	0.99/ha	Various	?	Mostly burrows	33	F	44-95[c]	Taylor, 1983

[a] Included *P. natalensis* and *R. pumilio* in the same study area.
[b] Recently bait shyness has been claimed.
[c] Included *Rattus norvegicus*, *R. rattus* and *Mus musculus* in same study area.

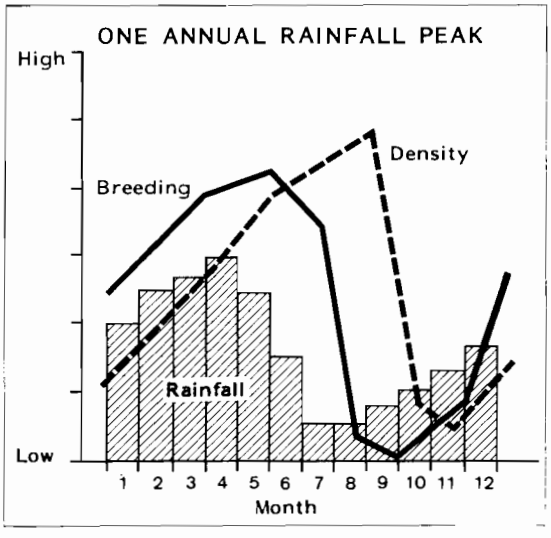
TABLE 3. **Selected list of rodenticides tested or used against *Praomys natalensis*, the Multimammate rat**

Chemical	Country	Conc. %	Bait	Amt. (kg)	Crop(s)	Months	Bait spacing and placement	Total area (ha)	Lab. (L) or field (F)	Mortality %	Reference
Zinc phosphide	Sudan	3.0	Crushed dura	2-6/ha	Grains	Dry season	—	—	F	—	Schmutterer, 1969
Zinc phosphide	UK	3.0	Medium oatmeal	—	—	—	—	—	L	60	Gill & Redfern, 1979
		4.0		—	—	—	—	—	L	100	Gill & Redfern, 1979
Zinc phosphide	Kenya	3.0	Maize meal	544	Young wheat, mature maize	Jul-Aug	5-m field edges	40 470	F	80[a]	Taylor, 1968
Warfarin	Zimbabwe	0.025-0.05	Wheat, cracked maize, rice	2/ha	Grains	—	75-100-m field edges	—	F	"Good"	Choate, 1975
Warfarin	Sudan	—	Crushed dura	—	—	—	Near dwellings	—	—	—	Schmutterer, 1969
Warfarin	Somalia	0.025	Crushed maize	10/ha later 3-4/ha	Grains, groundnut	July-Nov	50-80-m field edges	327 000	F	"Good"	Barre, 1978
Warfarin	UK	0.025	Medium oatmeal	—	—	—	—	—	L	50-100	Gill & Redfern, 1979
Chlorophacinone	Zimbabwe	0.005-0.01	Wheat, cracked maize and rice	2/ha	Grains	—	75-100-m field edges	—	F	"Good"	Choate, 1975
Dicoumarol	Zimbabwe	—	Wheat, cracked maize and rice	2/ha	Grains	—	75-100-m field edges	—	F	"Good"	Choate, 1975
Coumachlor	Zimbabwe	—	Wheat, cracked maize and rice	2/ha	Grains	—	75-100-m field edges	—	F	"Good"	Choate, 1975
Coumachlor	Somalia	0.025	Crushed maize	10/ha later 3-4/ha	Sesame, cotton	July-?	50-80 m	327 000	F	"Good"	Barre, 1978
Coumatetralyl	UK	0.0375	Medium oatmeal	—	—	—	—	—	L	50-100	Gill & Redfern, 1979
Difenacoum	UK	0.005	Medium oatmeal	—	—	—	—	—		30-100	Gill & Redfern, 1979
Difenacoum	Somalia	0.005	Ready made	10/ha later 3-4/ha	Grains, etc.	July-Nov	50-80 m	327 000	F	"Good"	Barre, 1978
Brodifacoum	UK	0.002	Medium oatmeal	—	—	—	—	—	L	35-100	Gill & Redfern, 1979
Bromadiolone	UK	0.005	Medium oatmeal	—	—	—	—	—	L	75-100	Gill & Redfern, 1979
Calciferol	UK	0.1	Pinhead oatmeal and maize oil	—	—	—	—	—	L	100	Gill & Redfern, 1979
Barium carbonate	Tanzania	?	Maize or sorghum meal[b]	—	—	—	—	—	F	"Most satis-factory"	Harris, 1937

[a] *Arvicanthis niloticus* also present.
[b] 1 part barium carbonate and 3 parts meal mixed and 2.3 kg (5 lb) maize or 3.6 kg (8 lb) sorghum meal stirred into 4 parts heated water. Mixture cooked and stirred for a few minutes, cooled, then moulded into 14 g (0.5 oz) balls or small cakes (6.35 mm/¼ in thick, 12.7 mm/½ in squares).

scenario, published data on rainfall, percentage of pregnant females and population density for *P. natalensis* populations have been summarized (see Figure). Maximum breeding occurred about 2 months after peak rainfall while population density levels peaked about 3.5 months after maximum breeding. Breeding declined with decreased rainfall. However, population density levels continued to increase until well after rainfall approached zero; numbers of *P. natalensis* then fell sharply. Published data from areas with two annual wet seasons show similar but bimodal patterns (Delany and Happold, 1979; Delany and Neal, 1969; Field, 1975). *A. niloticus* populations also express seasonal trends related to rainfall (Delany and Neal, 1969; Taylor and Green, 1976).

Data from an agricultural area in Senegal (Poulet, 1980) agree with the trends in non-agricultural habitats summarized in the Figure. In a 300-ha rice-growing area, breeding of *Praomys* was high in September 1975 (2 months after peak rainfall) and densities reached a maximum about 5-6 months after peak rainfall. Rains ended in October and *Praomys* populations fell sharply during the following dry season (January to June). *Arvicanthis* populations showed a similar pattern.



Source: Chapman, Chapman & Robertson, 1959; Coetzee, 1965; Hanney, 1965; Sheppe, 1972; Taylor & Green, 1976.

The relationship between rainfall and Praomys natalensis *breeding and population density levels*

Many agricultural crops are planted at the onset of rains or shortly after, and harvested near or after the end of the rainy season. Susceptible crop stages, such as planting or prior to harvest, frequently occur when pest rodent populations are near a peak. The significant damage that occurs during such times should be anticipated and preventive control methods developed that account for expected losses. Reports of significant damage problems in eastern Africa often occur in January and February (Fiedler, 1985), a time when crops have matured and rodent populations have increased. Crops harvested and temporarily stored in the field are particularly susceptible to significant losses.

Seasonal trends of rodent populations are affected by irrigation. The food, water and shelter present in irrigated crops attract rodents such as *Praomys* and *Arvicanthis* from unsuitable surrounding habitats (harvested and uncultivated fields) during the dry season (Fall, 1976, 1982). In Senegal, irrigated wheat prolonged rodent breeding and density levels well into the 1975 dry season compared to one year later when no irrigated crops were present (Poulet, 1980).

Major rodent outbreaks

After prolonged drought, the potential for a major rodent outbreak is great. Rainfall provides soil moisture that initiates very rapid vegetative growth. Disease, competition, and predation are only minimally present and those rodents that survive the drought immediately respond to these favourable conditions.

Rodent outbreaks have probably occurred in Africa for centuries but have only been recorded since 1905 (Pagliano, 1931). The rodent outbreak that affected much of the Sahelian zone in the mid-1970s was relatively well documented. In Senegal, Fall (1976) and Poulet (1980) reported high populations of

Arvicanthis, Praomys and *Taterillus*. Mali and Mauritania were likewise affected. Large populations of rodent pests were also reported in Nigeria (Brei, 1981) and several countries in eastern Africa (Akiev, 1982; Barre, 1978; Brei, 1981; Darlington, 1984; Kurylas, 1978). This outbreak followed a lengthy drought of up to seven years in some areas.

Rodent outbreaks in eastern Africa have been reported since 1920 when large number of *A. niloticus* occurred near Kampala, Uganda (Kingdon, 1974). The United Republic of Tanzania, Kenya, the Sudan, Zimbabwe and Somalia have also been subjected to periodic rodent outbreaks. Most involved *A. niloticus* and/or *P. natalensis*. Many outbreaks were associated with a preceding drought while some followed a period of excess rainfall.

Historical precedents for rodent outbreaks to occur after prolonged drought led to a general alert being issued in September 1984 from the Denver Wildlife Research Center (DWRC) to the United States Agency for International Development (USAID) Mission in Africa through the State Department AID/ Washington office. The possibility of severe rodent damage to crops in the Sahel and other drought-stricken African countries after rains began was outlined. The purpose of the alert was to provide early advice and to initiate prophylactic actions that would avoid a crisis response to outbreaks in progress. Crisis responses usually fail because of poor organization and a lack of money, personnel, materials, transport and time necessary to implement major control efforts effectively.

The rains returned to many drought-stricken areas in 1985. The Sudan received ideal rainfall during the 1985-86 and 1986-87 crop seasons resulting in bumper sorghum harvests. By August 1986, the Sudan had several areas with high rodent populations and by November 1986, Chad was likewise affected. In February 1987, both countries were requesting international assistance to cope with a major rodent outbreak. The rodent outbreak in the Sudan was assessed in April and a rodenticide baiting campaign was organized for western Sudan where sorghum and millet fields to be planted in June were at risk. During 1986 these fields suffered heavy losses and a second crop failure due to rodents in 1987 would probably have led to significant food shortages.

From late May until early August 1987, more than 1 000 tonnes of a rodenticide bait containing about 1 percent zinc phosphide mixed with 1 percent vegetable oil and 98 percent whole sorghum were applied to more than 1 million feddans [2] by burrow baiting in and around fields. Preliminary results from four provinces (North and South Kordofan, North and South Darfur) where 543 000 feddans were treated with 361 000 kg of bait showed a rodent index reduction of 72 (53-80) percent. The index was based on the number of rodents observed in daylight or within a headlight beam at night while driving for 1 km in several different places. More complete results were presented by Suliman (in press).

Conclusions

Rodent damage to agricultural crops in eastern Africa and evaluation of cost-effective management techniques are poorly documented. However, information that is available was extremely helpful in developing a strategy to deal with the 1986-87 major rodent outbreak in the Sudan. This rodent outbreak was a post-drought phenomenon that was highly predictable from historical precedent.

Annual chronic losses due to rodents in pre-harvest and post-harvest situations probably account for greater cumulative losses than the more visible and dramatic outbreak situations that periodically occur. More attention to priority crops and rodent pests would increase the knowledge of, and effectiveness in implementing, rodent pest management techniques in eastern Africa.

[2] One feddan equals 0.43 hectare (1.09 acre).

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